

What is Computer Science?



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Instructor — i.e., dedicated *teaching* faculty

- CS101: intro to the profession
- CS331: data structures
- CS351: systems programming
- CS450: operating systems
- CS495: programming patterns/paradigms



- ... and a few research interests:
- artificial intelligence
 - programming language design
 - concurrent programming



Just Two Questions

- What *is* Computer Science?
(What is it *not*?)
- What would you learn as a CS
undergrad?



A Misnomer

“Computer Science” is:

- a) not really about computers
- b) not really a science



Not about computers?

- Sure: we use computers as *tools*
- But so do folks in nearly every other data/computation intensive fields!
- Physics, Chemistry, Economics, Sociology, Music Production, etc.



We don't call physicists “collider experts”
or chemists “microscope specialists”



It *does help* to understand the internal workings of a computer (e.g., for “low-level” interactions and optimizations)



- *Computer & Electrical Engineers* actually design computer hardware
- You're encouraged to take some of those classes too!



Science?

science |'sīəns|

noun

the intellectual and practical activity encompassing the **systematic study** of the structure and behavior **of the physical and natural world** through **observation and experiment**

New Oxford American Dictionary



Science?

- i.e., the scientific method
- observe, hypothesize, experiment, analyze → refute/validate hypothesis



Yeah. We don't really do that.



“Computer Scientists” *solve problems.*

Systematically.

Then *analyze, generalize, and modularize*
our solutions to these problems.



e.g., Sudoku

“a human denial-of-service attack”

see <http://norvig.com/sudoku.html>



NYTimes Easy Puzzle

2	1	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	4	8	7
8	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	3	1 2 3 4 5 6 7 8 9	2	1 2 3 4 5 6 7 8 9	9	1
9	1 2 3 4 5 6 7 8 9	5	1 2 3 4 5 6 7 8 9	7	1	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	7	5	9	1 2 3 4 5 6 7 8 9	6	1	1 2 3 4 5 6 7 8 9
5	6	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1	3	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	2
4	1 2 3 4 5 6 7 8 9	1	6	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	7	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
1 2 3 4 5 6 7 8 9	3	9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	7	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
7	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	2	6
1	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	6	5	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	9

HOW TO PLAY

Fill the grid with your keyboard so that every row, column and 3×3 box contains the digits 1 to 9, without repeating.



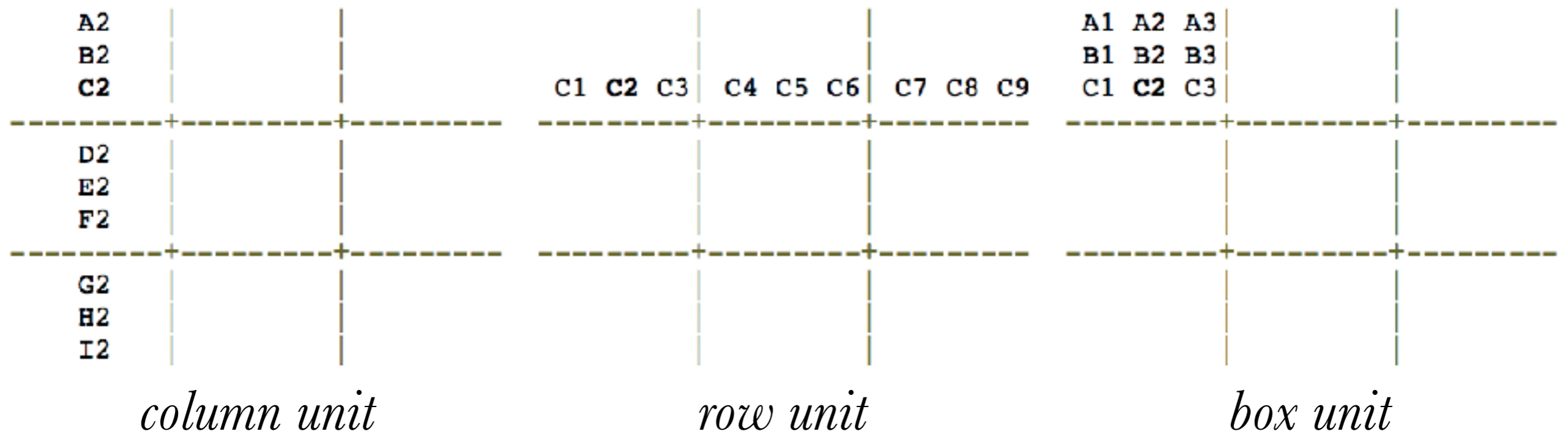
4	.	.	.	.	.	.	.	.	4	1	7	3	6	9	8	2	5
.	3	.	.	.	.	.	.	.	6	3	2	1	5	8	9	4	7
.	.	.	7	.	.	.	.	.	9	5	8	7	2	4	3	1	6
.	2	.	.	.	.	.	.	.	8	2	5	4	3	7	1	6	9
.	.	.	.	.	.	.	.	.	7	9	1	5	8	6	4	3	2
.	.	.	.	1	.	.	.	.	3	4	6	9	1	2	7	5	8
.	.	.	6	.	3	.	.	.	2	8	9	6	4	3	5	7	1
5	.	.	2	.	.	.	.	.	5	7	3	2	9	1	6	8	4
1	.	4	.	.	.	.	.	.	1	6	4	8	7	5	2	9	3



A1	A2	A3	|	A4	A5	A6	|	A7	A8	A9
B1	B2	B3	|	B4	B5	B6	|	B7	B8	B9
C1	C2	C3	|	C4	C5	C6	|	C7	C8	C9
-----			+	-----			+	-----		
D1	D2	D3	|	D4	D5	D6	|	D7	D8	D9
E1	E2	E3	|	E4	E5	E6	|	E7	E8	E9
F1	F2	F3	|	F4	F5	F6	|	F7	F8	F9
-----			+	-----			+	-----		
G1	G2	G3	|	G4	G5	G6	|	G7	G8	G9
H1	H2	H3	|	H4	H5	H6	|	H7	H8	H9
I1	I2	I3	|	I4	I5	I6	|	I7	I8	I9

1. name our squares





2. identify a square's (e.g., **C2**'s) "peers"



123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789
123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789
123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789
123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789
123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789
123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789
123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789
123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789
123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789
123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789

3. start with a “catch-all” solution



4. *Recursively* apply a general AI approach known as “constraint satisfaction”



rules (aka “constraints”):

- If a square has only one possible value, then *eliminate* that value from its peers
- If a unit has only one possible square for a value, then *assign* the value there



4		8	.	5
.	3
.	.	.		7
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.	2	6	.
.	.	.		.	8	.		4	.	.
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.	.	.		6	.	3		.	7	.
5	.	.		2
1	.	4	

123456789	123456789	123456789		123456789	123456789	123456789		123456789	123456789	123456789
123456789	123456789	123456789	|	123456789	123456789	123456789	|	123456789	123456789	123456789
123456789	123456789	123456789		123456789	123456789	123456789		123456789	123456789	123456789
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123456789	123456789	123456789		123456789	123456789	123456789		123456789	123456789	123456789
123456789	123456789	123456789	|	123456789	123456789	123456789	|	123456789	123456789	123456789
123456789	123456789	123456789		123456789	123456789	123456789		123456789	123456789	123456789
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123456789	123456789	123456789		123456789	123456789	123456789		123456789	123456789	123456789
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123456789	123456789	123456789		123456789	123456789	123456789		123456789	123456789	123456789

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5	.	.		2	
1	.	4		

123456789	123	56789	123	56789		123	56789	123	56789	123	56789		123	56789	123	56789	123	56789	123	56789
123	56789	123	56789	123	56789	|	123456789	123456789	123456789	|	123456789	123456789	123456789	|	123456789	123456789	123456789	123456789	123456789	123456789
123	56789	123	56789	123	56789		123456789	123456789	123456789		123456789	123456789	123456789		123456789	123456789	123456789	123456789	123456789	123456789
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123	56789	123456789	123456789		123456789	123456789	123456789		123456789	123456789	123456789		123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789
123	56789	123456789	123456789	|	123456789	123456789	123456789	|	123456789	123456789	123456789	|	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789
123	56789	123456789	123456789		123456789	123456789	123456789		123456789	123456789	123456789		123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789
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123	56789	123456789	123456789		123456789	123456789	123456789		123456789	123456789	123456789		123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789
123	56789	123456789	123456789	|	123456789	123456789	123456789	|	123456789	123456789	123456789	|	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789
123	56789	123456789	123456789		123456789	123456789	123456789		123456789	123456789	123456789		123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789

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5	.	.		2	
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4	123	56789	123	56789		123	56789	123	56789	123	56789	123	56789	123	56789	123	56789			
123	56789	123	56789	123	56789	|	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789			
123	56789	123	56789	123	56789		123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789			
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123	56789	123456789	123456789	123456789		123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789			
123	56789	123456789	123456789	123456789		123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789			
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123	56789	123456789	123456789	123456789		123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789			
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123	56789	123456789	123456789	123456789		123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789	123456789			

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5	.	.		2
1	.	4	

4	123	56789	123	56789		123	56789	123	56789	123	56789		123	56789	123	56789	123	56789
123	56789	123	56789	123	56789		123456789	123456789	123456789		123456789	123456789		123456789	123456789	123456789	123456789	123456789
123	56789	123	56789	123	56789		123456789	123456789	123456789		123456789	123456789		123456789	123456789	123456789	123456789	123456789
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123	56789	123456789	123456789		123456789	123456789	123456789		123456789	123456789	123456789		123456789	123456789	123456789	123456789	123456789	123456789

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1	.	4	

4	123	567	9	123	567	9		123	567	9	123	567	9	123	567	9		123	56789	123	567	9	123	567	9				
123	56789	123	56789	123	56789	123	56789		123456789	123456789	123456789	123456789		1234567	9	1234567	9		1234567	9	1234567	9	1234567	9	1234567	9			
123	56789	123	56789	123	56789	123	56789		123456789	123456789	123456789	123456789		1234567	9	1234567	9		1234567	9	1234567	9	1234567	9	1234567	9			
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123	56789	123456789	123456789		123456789	123456789	123456789		1234567	9	123456789	123456789		1234567	9	123456789	123456789		1234567	9	123456789	123456789	123456789	123456789		1234567	9	123456789	123456789
123	56789	123456789	123456789	|	123456789	123456789	123456789	|	1234567	9	123456789	123456789	|	1234567	9	123456789	123456789	|	1234567	9	123456789	123456789	123456789	123456789	|	1234567	9	123456789	123456789
123	56789	123456789	123456789		123456789	123456789	123456789		1234567	9	123456789	123456789		1234567	9	123456789	123456789		1234567	9	123456789	123456789	123456789	123456789		1234567	9	123456789	123456789
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123	56789	123456789	123456789		123456789	123456789	123456789		1234567	9	123456789	123456789		1234567	9	123456789	123456789		1234567	9	123456789	123456789	123456789	123456789		1234567	9	123456789	123456789
123	56789	123456789	123456789	|	123456789	123456789	123456789	|	1234567	9	123456789	123456789	|	1234567	9	123456789	123456789	|	1234567	9	123456789	123456789	123456789	123456789	|	1234567	9	123456789	123456789
123	56789	123456789	123456789		123456789	123456789	123456789		1234567	9	123456789	123456789		1234567	9	123456789	123456789		1234567	9	123456789	123456789	123456789	123456789		1234567	9	123456789	123456789

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1	.	4	

4	123	567	9	123	567	9		123	567	9	123	567	9	123	567	9		8	123	567	9	123	567	9
123	56789	123	56789	123	56789	123	56789		123456789	123456789	123456789	123456789		1234567	9	1234567	9		1234567	9	1234567	9	1234567	9
123	56789	123	56789	123	56789	123	56789		123456789	123456789	123456789	123456789		1234567	9	1234567	9		1234567	9	1234567	9	1234567	9
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123	56789	123456789	123456789		123456789	123456789	123456789		1234567	9	123456789	123456789		1234567	9	123456789	123456789		1234567	9	123456789	123456789	123456789	123456789
123	56789	123456789	123456789	|	123456789	123456789	123456789	|	1234567	9	123456789	123456789	|	1234567	9	123456789	123456789	|	1234567	9	123456789	123456789	123456789	123456789
123	56789	123456789	123456789		123456789	123456789	123456789		1234567	9	123456789	123456789		1234567	9	123456789	123456789		1234567	9	123456789	123456789	123456789	123456789
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123	56789	123456789	123456789		123456789	123456789	123456789		1234567	9	123456789	123456789		1234567	9	123456789	123456789		1234567	9	123456789	123456789	123456789	123456789
123	56789	123456789	123456789	|	123456789	123456789	123456789	|	1234567	9	123456789	123456789	|	1234567	9	123456789	123456789	|	1234567	9	123456789	123456789	123456789	123456789
123	56789	123456789	123456789		123456789	123456789	123456789		1234567	9	123456789	123456789		1234567	9	123456789	123456789		1234567	9	123456789	123456789	123456789	123456789

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.	.	.		6	.	3		.	7	.
5	.	.		2
1	.	4	

4	1679	12679		139	2369	269		8	1239	5
26789	3	1256789		14589	24569	245689		12679	1249	124679
2689	15689	125689	|	7	234569	245689	|	12369	12349	123469
-----+-----+-----										
3789	2	15789	|	3459	34579	4579	|	13579	6	13789
3679	15679	15679	|	359	8	25679	|	4	12359	12379
36789	4	56789	|	359	1	25679	|	23579	23589	23789
-----+-----+-----										
289	89	289	|	6	459	3	|	1259	7	12489
5	6789	3	|	2	479	1	|	69	489	4689
1	6789	4	|	589	579	5789	|	23569	23589	23689

(some squares are solved)



How to proceed?

$2.31419172096 * 10^{39}$ combinations!

4	1679	12679	|	139	2369	269	|	8	1239	5
26789	3	1256789	|	14589	24569	245689	|	12679	1249	124679
2689	15689	125689	|	7	234569	245689	|	12369	12349	123469
-----+-----+-----										
3789	2	15789	|	3459	34579	4579	|	13579	6	13789
3679	15679	15679	|	359	8	25679	|	4	12359	12379
36789	4	56789	|	359	1	25679	|	23579	23589	23789
-----+-----+-----										
289	89	289	|	6	459	3	|	1259	7	12489
5	6789	3	|	2	479	1	|	69	489	4689
1	6789	4	|	589	579	5789	|	23569	23589	23689



How to proceed?

~ 10,000,000,000,000,000,000,000 years!

4	1679	12679	|	139	2369	269	|	8	1239	5
26789	3	1256789	|	14589	24569	245689	|	12679	1249	124679
2689	15689	125689	|	7	234569	245689	|	12369	12349	123469
-----+-----+-----										
3789	2	15789	|	3459	34579	4579	|	13579	6	13789
3679	15679	15679	|	359	8	25679	|	4	12359	12379
36789	4	56789	|	359	1	25679	|	23579	23589	23789
-----+-----+-----										
289	89	289	|	6	459	3	|	1259	7	12489
5	6789	3	|	2	479	1	|	69	489	4689
1	6789	4	|	589	579	5789	|	23569	23589	23689



5. Choose the square with the *minimum number of possible values* > 1 , and “guess” a value to *assign* to the square
 - If our constraints aren't met, *backtrack*
 - (computers have perfect memory!)



4 . .	. . .	8 . 5
. 3 .	. . .	. . .
. . .	7 . .	. . .
+-----+		
. 2 .	. . .	. 6 .
. . .	. 8 .	4 . .
. . .	. 1 .	. . .
+-----+		
. . .	6 . 3	. 7 .
5 . .	2 . .	. . .
1 . 4	. . .	. . .

4	1679	12679	139	2369	269	8	1239	5
26789	3	1256789	14589	24569	245689	12679	1249	124679
2689	15689	125689	7	234569	245689	12369	12349	123469
+-----+								
3789	2	15789	3459	34579	4579	13579	6	13789
3679	15679	15679	359	8	25679	4	12359	12379
36789	4	56789	359	1	25679	23579	23589	23789
+-----+								
289	89	289	6	459	3	1259	7	12489
5	6789	3	2	479	1	69	489	4689
1	6789	4	589	579	5789	23569	23589	23689

4	8 . 5
. 3
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+		
. 2 6 .
. . .	. 8 .	4 . .
. . .	. 1
+		
. . .	6 . 3	. 7 .
5 . .	2
1 . 4

4	1679	12679	139	2369	269	8	1239	5
26789	3	1256789	14589	24569	245689	12679	1249	124679
2689	1569	125689	7	234569	245689	12369	12349	123469
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3789	2	15789	3459	34579	4579	13579	6	13789
3679	15679	15679	359	8	25679	4	12359	12379
36789	4	56789	359	1	25679	23579	23589	23789
+								
29	8	29	6	459	3	1259	7	1249
5	679	3	2	479	1	69	489	4689
1	679	4	589	579	5789	23569	23589	23689

4	8 . 5
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. 2 6 .
. . .	. 8 .	4 . .
. . .	. 1
. . .	6 . 3	. 7 .
5 . .	2
1 . 4

4	1679	12679	139	2369	269	8	1239	5
26789	3	1256789	14589	24569	245689	12679	1249	124679
2689	1569	125689	7	234569	245689	12369	12349	123469
3789	2	15789	3459	34579	4579	13579	6	13789
3679	15679	15679	359	8	25679	4	12359	12379
36789	4	56789	359	1	25679	23579	23589	23789
29	8	29	6	459	3	1259	7	1249
5	679	3	2	479	1	69	489	4689
1	679	4	589	579	5789	23569	23589	23689

4 . .	. . .	8 . 5
. 3 .	. . .	. . .
. . .	7 . .	. . .
. 2 .	. . .	. 6 .
. . .	. 8 .	4 . .
. . .	. 1 .	. . .
. . .	6 . 3	. 7 .
5 . .	2 . .	. . .
1 . 4	. . .	. . .

4	1679	1267	139	2369	269	8	1239	5
6789	3	125678	14589	24569	245689	12679	1249	124679
689	1569	12568	7	234569	245689	12369	12349	123469
3789	2	1578	3459	34579	4579	13579	6	13789
3679	15679	1567	359	8	25679	4	12359	12379
36789	4	5678	359	1	25679	23579	23589	23789
2	8	9	6	45	3	15	7	14
5	67	3	2	479	1	69	489	4689
1	67	4	589	579	5789	23569	23589	23689

4	8 . 5
. 3
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. 2 6 .
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. . .	6 . 3	. 7 .
5 . .	2
1 . 4

4	1679	1267	139	2369	269	8	1239	5
6789	3	125678	14589	24569	245689	12679	1249	124679
689	1569	12568	7	234569	245689	12369	12349	123469
3789	2	1578	3459	34579	4579	13579	6	13789
3679	15679	1567	359	8	25679	4	12359	12379
36789	4	5678	359	1	25679	23579	23589	23789
2	8	9	6	45	3	15	7	14
5	67	3	2	479	1	69	489	4689
1	67	4	589	579	5789	23569	23589	23689

4		8	.	5
.	3
.	.	.		7
-----+-----+-----										
.	2	6	.
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5	.	.		2
1	.	4	

4	1679	1267		139	2369	269		8	1239	5
6789	3	125678		14589	2569	245689		12679	1249	24679
689	1569	12568	|	7	23569	245689	|	12369	12349	23469
-----+-----+-----										
3789	2	1578	|	3459	3579	4579	|	1379	6	3789
3679	15679	1567	|	359	8	25679	|	4	12359	2379
36789	4	5678		359	1	25679		2379	23589	23789
-----+-----+-----										
2	8	9		6	4	3		5	7	1
5	67	3		2	79	1		69	489	4689
1	67	4		589	579	5789		2369	2389	23689

4	8 . 5
. 3
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. 2 6 .
. . .	. 8 .	4 . .
. . .	. 1
. . .	6 . 3	. 7 .
5 . .	2
1 . 4

4	1679	1267	139	2369	269	8	1239	5
6789	3	125678	14589	2569	245689	12679	1249	24679
689	1569	12568	7	23569	245689	12369	12349	23469
3789	2	1578	3459	3579	4579	1379	6	3789
3679	15679	1567	359	8	25679	4	12359	2379
36789	4	5678	359	1	25679	2379	23589	23789
2	8	9	6	4	3	5	7	1
5	67	3	2	79	1	69	489	4689
1	67	4	589	579	5789	2369	2389	23689

4		8	.	5
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-----+										
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.	.	.		.	1
-----+										
.	.	.		6	.	3		.	7	.
5	.	.		2
1	.	4	

4	1	7		3	2	4		8	9	5
689	3	28		1	569	4589		267	24	2467
689	5	28		7	2569	4689		236	1	2346
-----+										
8	2	5	|	4	3	7	|	1	6	9
379	9	1	|	5	8	6	|	4	235	237
37	4	6	|	9	1	2	|	37	358	378
-----+										
2	8	9	|	6	4	3	|	5	7	1
5	6	3	|	2	7	1	|	9	48	48
1	7	4	|	8	59	59	|	236	23	236

error!

4	.	.	|	.	.	.	|	8	.	5
.	3	.	|	.	.	.	|	.	.	.
.	.	.	|	7	.	.	|	.	.	.
-----+										
.	2	.	|	.	.	.	|	.	6	.
.	.	.	|	.	8	.	|	4	.	.
.	.	.	|	.	1	.	|	.	.	.
-----+										
.	.	.	|	6	.	3	|	.	7	.
5	.	.	|	2	.	.	|	.	.	.
1	.	4	|	.	.	.	|	.	.	.

4	1679	1267	|	139	2369	269	|	8	1239	5
6789	3	125678	|	14589	2569	245689	|	12679	1249	24679
689	1569	12568	|	7	23569	245689	|	12369	12349	23469
-----+										
3789	2	1578	|	3459	3579	4579	|	1379	6	3789
3679	15679	1567	|	359	8	25679	|	4	12359	2379
36789	4	5678	|	359	1	25679	|	2379	23589	23789
-----+										
2	8	9		6	4	3		5	7	1
5	67	3		2	79	1		69	489	4689
1	67	4		589	579	5789		2369	2389	23689

(backtrack!)



4		8	.	5
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.	.	.		7
-----+-----+-----										
.	2	6	.
.	.	.		.	8	.		4	.	.
.	.	.		.	1
-----+-----+-----										
.	.	.		6	.	3		.	7	.
5	.	.		2
1	.	4	

4	19	7		139	236	269		8	1239	5
689	3	12568		14589	256	245689		1279	1249	24679
689	159	12568	|	7	2356	245689	|	1239	12349	23469
-----+-----+-----										
3789	2	158	|	3459	357	4579	|	1379	6	3789
3679	159	156	|	359	8	25679	|	4	12359	2379
36789	4	568	|	359	1	25679	|	2379	23589	23789
-----+-----+-----										
2	8	9	|	6	4	3	|	5	7	1
5	7	3	|	2	9	1	|	6	48	48
1	6	4	|	58	57	578	|	239	2389	2389

4 . .	. . .	8 . 5
. 3 .	. . .	. . .
. . .	7 . .	. . .
+ + +		
. 2 .	. . .	. 6 .
. . .	. 8 .	4 . .
. . .	. 1 .	. . .
+ + +		
. . .	6 . 3	. 7 .
5 . .	2 . .	. . .
1 . 4	. . .	. . .

4 1 7	3 6 9	8 2 5
6 3 2	1 5 8	9 4 7
9 5 8	7 2 4	3 1 6
+ + +		
8 2 5	4 3 7	1 6 9
7 9 1	5 8 6	4 3 2
3 4 6	9 1 2	7 5 8
+ + +		
2 8 9	6 4 3	5 7 1
5 7 3	2 9 1	6 8 4
1 6 4	8 7 5	2 9 3

(a few microseconds later)



Ultimate Problem Solvers

- After coming up with a solution — *aka an algorithm* — a monkey can apply it!
- A monkey with perfect memory, that will follow instructions to the letter
- I.e., a computer



Programs

- We codify solutions into *programs* which computers can execute
- And, ideally, reuse our code to build every grander programs!



Programs have *billions* of moving pieces!

The Great Wall of China has nothing on
an operating system kernel's codebase.

Nor does any ingenuous *mechanical device*.



Also: *Meta*-Problems

e.g., what *classes* of problems exist?

how *hard* is a problem to solve?

can we solve a given problem?





IN CS, IT CAN BE HARD TO EXPLAIN
THE DIFFERENCE BETWEEN THE EASY
AND THE VIRTUALLY IMPOSSIBLE.

<http://xkcd.com/1425/>



Most important takeaway: how to *analyze, break down, and solve problems*

Pattern recognition and reuse are critical skills!



Much of Computer Science also deals
with *managing complexity*

- analyzing and optimizing algorithms



What will you learn?

- Programming languages
- Techniques to *design, analyze, optimize,* and *implement* algorithms
- Approaches to leveraging new technologies & software paradigms

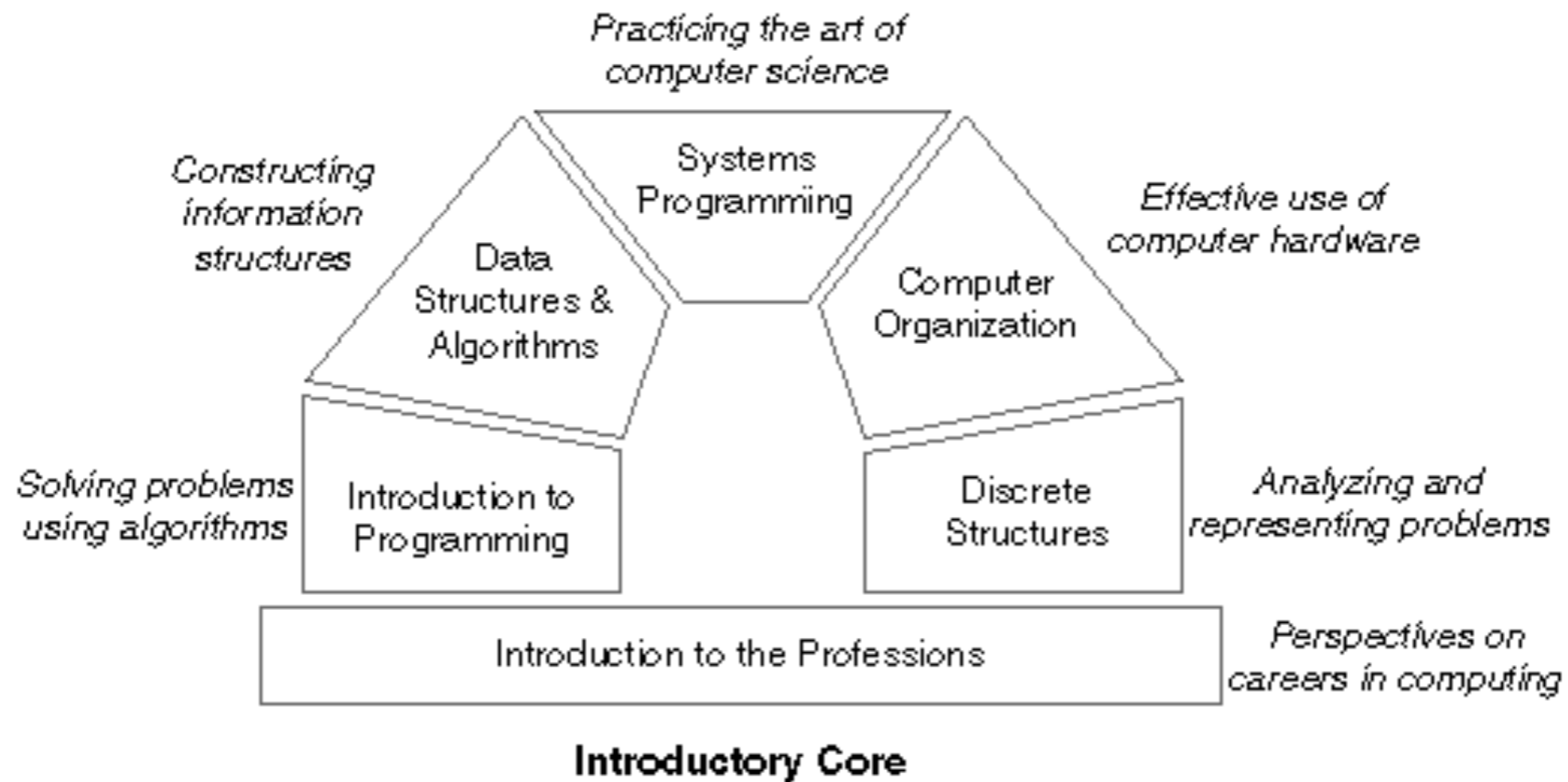


Two Majors

- B.S. in Computer Science
 - An engineering degree focusing on the theory and practice of computer science
- B.S. in Computer Information Systems
 - Focuses on the development of applications software



Core Curriculum



Upper Level Classes

- Computers and Society
- Database Organization
- Introduction to Algorithms
- Introduction to Operating Systems
- Programming Languages and Translators
- Software Engineering



Electives

- Artificial Intelligence
- Biometrics
- Cloud Computing
- Compiler Construction
- Computer Architecture
- Data Communications
- Data Mining
- Geospatial Vision & Visualization
- Graphics
- Information Retrieval
- Information Security
- Intelligent Text Analysis
- Knowledge Management Systems
- Mobile Computing
- OO Prog. & Design
- Wireless Networks



Other options

- Co-terminal degree option - BS in CS and MS in CS (or Data Science)
- Undergraduate Specializations:
 - Data Science, Distributed and Cloud Computing, Information Security, Information and Knowledge Management Systems.
- Undergrad research opportunities



Questions?

